



**SURVIVABILITY • SUSTAINABILITY • MOBILITY  
SCIENCE AND TECHNOLOGY  
SOLDIER SYSTEM INTEGRATION**



**TECHNICAL REPORT  
NATICK/TR-96/044**

**AD \_\_\_\_\_**

# **THE EFFECTS OF PACKAGING CONDITIONS ON THE SENSORY QUALITY OF TRAIL MIX AFTER STORAGE**

**By  
Carol P. Shaw  
Daniel T. Nattress**

**September 1996**

**FINAL REPORT  
November 1993 - November 1995**

**Approved for Public Release; Distribution Unlimited**

**U.S. ARMY SOLDIER SYSTEMS COMMAND  
NATICK RESEARCH, DEVELOPMENT AND ENGINEERING CENTER  
NATICK, MASSACHUSETTS 01760-5018  
SUSTAINABILITY DIRECTORATE**

**DTIC QUALITY INSPECTED 3**

19961018 139

### DISCLAIMERS

The findings contained in this report are not to be construed as an official Department of the Army position unless so designated by other authorized documents.

Citation of trade names in this report does not constitute an official endorsement or approval of the use of such items.

### DESTRUCTION NOTICE

#### For Classified Documents:

Follow the procedures in DoD 5200.22-M, Industrial Security Manual, Section II-19 or DoD 5200.1-R, Information Security Program Regulation, Chapter IX.

#### For Unclassified/Limited Distribution Documents:

Destroy by any method that prevents disclosure of contents or reconstruction of the document.

# REPORT DOCUMENTATION PAGE

Form Approved  
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE September 1996		3. REPORT TYPE AND DATES COVERED FINAL Nov 1993 - Nov 1995	
4. TITLE AND SUBTITLE THE EFFECTS OF PACKAGING CONDITIONS ON THE SENSORY QUALITY OF TRAIL MIX AFTER STORAGE				5. FUNDING NUMBERS PR 1L162724AH99 TA AH99b AG MSR1545	
6. AUTHOR(S) Carol P. Shaw and Daniel T. Nattress					
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) U.S. Army Soldier Systems Command (SSCOM) Natick Research, Development and Engineering Center Kansas St. ATTN: SSCNC-WRD Natick, MA 01760-5018				8. PERFORMING ORGANIZATION REPORT NUMBER NATICK/TR-96/044	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSORING/MONITORING AGENCY REPORT NUMBER	
11. SUPPLEMENTARY NOTES					
12a. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited				12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words) To determine the effects of vacuum packaging versus oxygen scavengers on the stability of nut raisin trail mix, samples were assessed by sensory panels initially and after storage for one and three months at 27, 38 and 49°C and six months at 27 and 38°C. Variable A contained 15% raisins and an 85% mixture of peanuts, walnuts, almonds and filberts packaged in a trilaminate barrier material with 28" vacuum. Variable B had no vacuum but an oxygen scavenger. Variable C was similar to A but had 22% raisins and 78% nuts. Panel members rated attributes and overall ratings on specially designed scales. Multiple range analyses showed that treatment, time and temperature had no significant effects initially, but with increasing time and temperature the vacuum packed samples rated significantly lower than samples with an oxygen scavenger. Treatment B was not significantly affected by time at any temperature, whereas treatments A and C had significant degradation over time at all temperatures. The raisins in the vacuum packed samples agglomerated upon storage, especially with increased storage temperatures and increased raisins. Vacuum packaging may have deleterious effects that may be evident only under adverse storage conditions or without strict control of the fruit.					
14. SUBJECT TERMS PACKAGING SENSORY ANALYSIS NUTS (FRUITS)		STORAGE STORAGE STABILITY VACUUM PACKED TEMPERATURE		15. NUMBER OF PAGES 23	
		OXYGEN SCAVENGING DEGRADATION TIME		16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT UNCLASSIFIED	18. SECURITY CLASSIFICATION OF THIS PAGE UNCLASSIFIED	19. SECURITY CLASSIFICATION OF ABSTRACT UNCLASSIFIED	20. LIMITATION OF ABSTRACT SAR		

## TABLE OF CONTENTS

	Page
List of Figures .....	v
List of Tables .....	vii
Preface .....	ix
Introduction .....	1
Objectives .....	2
Materials and Methods .....	2
Results and Discussion .....	3
References .....	7
Appendix .....	9

## LIST OF FIGURES

	Page
Figure 1. Overall Quality Ratings of Trail Mix Stored at 27°C .....	10
Figure 2. Overall Quality Ratings of Trail Mix Stored at 38°C .....	11
Figure 3. Overall Quality Ratings of Trail Mix Stored at 49°C .....	12
Figure 4. Appearance Ratings of Trail Mix Stored at 27°C .....	13
Figure 5. Appearance Ratings of Trail Mix Stored at 38°C .....	14
Figure 6. Appearance Ratings of Trail Mix Stored at 49°C .....	15

## LIST OF TABLES

	Page
Table 1. Attribute Ratings used by the Sensory Panel .....	3
Table 2. Results of Moisture Determinations on Variables A, B, and C .....	3
Table 3. Mean Attribute Ratings of Trail Mix after Storage at 27, 38, 49°C for Various Time Periods.....	5

## PREFACE

This effort was undertaken under the work unit on Accelerated Testing, Project Number 1L162724AH99, Joint Services Food/Nutrition Technology, in the program entitled Food Stabilization and Shelf Life Indices for Military Feed at Environmental Extremes, Program ID AD94-17. This program was undertaken in the Sustainability Directorate in the Natick Research, Development, and Engineering Center, U.S. Army Soldier Systems Command. The authors would like to thank Ms. Mary Friel, Ms. Janine Campbell, and Ms. Melanie Morse for their assistance in this project.

# THE EFFECTS OF PACKAGING CONDITIONS ON THE SENSORY QUALITY OF TRAIL MIX AFTER STORAGE

## INTRODUCTION

A trail mix, comprised of peanuts, walnuts, almonds, filberts and raisins, is included in the military ration designed for cold environments. The trail mix adds variety, high acceptability, resistance to freezing, caloric density and eat-out-of hand convenience to the ration. In the past two decades fruit and nut combinations have grown in popularity and are promoted as nutritious snacks (Estevez et al 1995, Prompovich 1980) and good sources of protein, vitamin A, potassium, iron and fiber (Silge and Callon 1983).

The shelf life mandated for military rations is three years at 27°C and six months at 38°C. This shelf stability is difficult to achieve in a product with a relatively high fat content (30%) and with ingredients differing greatly in moisture content and water activity. Lipid oxidation is controlled with coatings of edible shellac or corn protein (zein) as well as antioxidants on the peanuts and walnuts. Although raisins have mold inhibiting properties and humectant properties (Lagrange and Paine 1988, Ziemke 1980, Duxbury 1986) that are beneficial to stability, the combined nut raisin mix tends to aggregate or clump together, and the raisins may become hard and sticky after storage. The storage stability of raisins alone have been studied under various storage temperatures and conditions (Canellas 1993) with different drying procedures (Stafford and Guadagni 1977), and with a microwave pre-treatment (Kostaropoulos and Saravacos 1995). The relationship and effects of moisture content, water activity, and water sorption isotherms have also been investigated (Ayranci et al. 1990, Tsami et al. 1990). Control of the texture and the crystallization of raisins was studied by Bolin in 1976 who found a mild heat treatment and various coatings on the raisins to be beneficial. Previous unpublished research has been conducted at SSCOM on various coatings for both the nuts and the raisins. An oil coating is required on the raisins to reduce the agglomeration.

This present research effort was undertaken to determine if packaging and/or quality assurance factors have a significant impact on the storage stability of the trail mix. The shelf life requirement of the trail mix has been especially difficult to achieve consistently when commercially manufactured. The specification requires that the moisture content of the total finished product (nut and raisin mixture) be not greater than 5.0 percent. The moisture content testing must be determined in accordance with the Nut and Nut Products chapter, vacuum oven method of the Official Methods of Analysis of the Association of Analytical Chemists (AOAC). The raisins themselves must be Thompson seedless and between 10 and 15 percent moisture.. The specification also states that the "final blended product shall be free of clumped nuts and raisins such that product is free flowing and clumps can be broken with light finger pressure" (Anonymous 1987).

## OBJECTIVES

The objectives of this study were to determine if vacuum packaging or non-vacuum packaging with an oxygen scavenger was the preferred packaging method for the trail mix and to determine if the amount of raisins in each pouch was critical to the stability.

## MATERIALS AND METHODS

Trail mix was prepared according to the military specification for nut raisin mix (MIL-N-44280 GL, Anonymous, 1987). Variable A, prepared as the product is currently manufactured, contained 15% raisins and an 85% mixture of nuts containing peanuts (65%), walnuts (10%), almonds (5%) and filberts (5%). The peanuts and walnuts were separately coated with a 1.5 % zein coating dissolved in alcohol to arrive at a 0.05% coating on the nuts. After the dissipation of the alcohol, almonds and filberts were added and mixed. For each pouch 102 grams (85%) of the nut mixture was blended with 18 grams of raisins (15%), filled into flexible pouches made of foil trilaminate barrier material, and sealed under 28 inches of vacuum. Variable B was made similarly but packaged without vacuum and with an oxygen scavenger containing reduced iron with a 100cc O<sub>2</sub> capacity. Variable C was similar to Variable A but contained 22% raisins and 78% nuts.

The mean moisture content of the raisins incorporated into the trail mix was 10.8 percent. Additional moisture determinations were made on samples of each trail mix variable by two methods of determination, a five hour vacuum drying procedure at 100°C and a six hour vacuum drying procedure at 70°C. The five hour vacuum drying procedure is the one specified for the product as described in the Nut and Nut Products (925.40) section of the Official Methods of Analysis of the Association of Official Analytical Chemists (AOAC). Ten samples of each variable were analyzed.

The products were evaluated by sensory panels initially and after storage for one and three months at 27, 38 and 49°C and six months at 27 and 38°C. The panels were comprised of 15-20 food technologists who were experienced in testing ration components. The panelists rated seven attributes (Table 1) on a nine point scale in which five usually indicated fair or intermediate, and the one and nine values the extremes. The seventh attribute "overall quality" is standardly used in evaluating military ration components.

Table 1. Attribute ratings used by the sensory panel.

	1 =	5 =	9 =
Appearance	extremely poor	fair	excellent
Odor, nut component	very stale	intermediate	very fresh
Flavor, nut mixture	very stale	intermediate	very fresh
Raisin flavor	extremely poor	fair	excellent
Texture, nuts	very soft	intermediate	very hard
Texture, raisins	very soft	fair	very hard
Overall quality of mixture	extremely poor	fair	excellent

The data were analyzed using Minitab Statistical Package, Release 10 for Windows by Minitab Inc. of State College, PA. The data were first subjected to multiple range analyses to determine the effects of treatment, time and temperature. Regression analyses and analyses of variance were then performed to determine the specific effects.

## RESULTS AND DISCUSSION

Moisture determinations. Results of moisture determinations, (Table 2) show that Variables A and B were within the 5.0% moisture requirement mandated in the specification by both drying procedures. Variable C met the requirement when analyzed by the longer drying procedure at a lower temperature, but not by the drying at 100°C. Because the five hour is the required moisture procedure, Variable C would not have met the specification.

Table 2. Results of Moisture Determinations on Variables A, B, and C.

	Variable A		Variable B		Variable C	
Method	5 hours @ 100C	6 hours @ 70C	5 hours @ 100C	6 hours @ 70C	5 hours @ 100C	6 hours @ 70C
Mean	4.68	3.53	4.58	3.64	5.29	4.27
Standard deviation	0.22	0.19	0.23	0.15	0.32	0.15

Sensory results The mean sensory ratings for the attributes are listed in Table 3. Multiple range analyses of the data showed that treatment, time and temperature had significant effects of the rating of overall quality. There were no significant differences in overall ratings initially but with increasing storage time and temperature the vacuumed packed samples rated lower than the samples with an oxygen scavenger. Regression analyses show that treatment B with an oxygen scavenger was not significantly affected by time at any temperature, whereas the vacuum packaged samples with either level of raisins had significant degradation over time at all temperatures. The products with the higher amount of raisins were rated slightly higher initially (although not statistically significant), but degraded the most at all temperatures.

Figure 1 illustrates the ratings of the three products on storage at 27°C. It shows no statistically significant differences until six months of storage. When the products were stored at 38°C (Figure 2), significant changes were found after one month of storage. At 49°C (Figure 3) significant changes occurred at three months.

Although there were significant differences in almost all of the attributes for time, treatment, and temperature, the appearance attribute showed the greatest change. (Figures 4, 5 and 6). The raisins agglomerated in the vacuum packaged variables both together and with the nuts, resulting in a poorer appearance. This effect was not evident initially and was exaggerated with increased amounts of raisins and the higher temperatures of storage. This indicates that the effects may only be evident under adverse storage conditions. It also demonstrates the importance of strict quality control in the amount of raisins in each package.

TABLE 3. MEAN ATTRIBUTE RATINGS OF TRAIL MIX AFTER STORAGE AT 27, 38, 49 C FOR VARIOUS TIME PERIODS

	INITIAL			1 MONTH 27C			1 MONTH 38C			1 MONTH 49C			3 MONTHS 27C			3 MONTHS 38C			3 MONTHS 49C			6 MONTHS 27C			6 MONTHS 38C			
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
OVERALL QUALITY	MEAN	5.4	5.7	6.2	6.1	6.4	6.2	5.2	6.3	5.2	5.9	6.0	5.8	6.1	6.2	5.5	4.8	5.9	3.5	3.9	5.1	3.2	5.7	6.3	5.3	4.4	5.7	3.6
	S.D.	1.8	1.6	1.3	1.6	1.7	1.7	1.2	1.1	0.9	0.8	1.1	1.4	1.2	1.3	1.2	1.2	1.3	1.5	1.5	1.5	1.2	1.0	1.8	1.3	1.3	1.2	1.5
ODOR, NUT COMP.	MEAN	5.5	5.8	6.3	5.9	6.0	5.8	5.1	5.8	5.2	5.9	5.5	5.4	5.8	6.0	5.1	4.7	5.6	4.1	4.2	4.7	3.5	5.6	6.1	5.0	5.1	4.9	3.9
	S.D.	2.0	1.8	1.5	1.1	1.0	1.1	1.6	1.1	1.6	1.2	1.3	1.4	1.3	1.3	1.6	1.5	1.8	1.7	1.7	1.1	1.5	1.3	1.0	1.6	1.2	1.6	1.4
FLAVOR, NUT MIX.	MEAN	4.7	5.5	6.0	5.6	5.8	5.6	5.0	6.1	4.8	5.8	5.5	5.3	5.9	5.8	5.4	4.9	5.5	4.0	4.5	4.7	3.7	5.1	5.3	4.7	4.6	5.4	3.6
	S.D.	2.4	2.0	1.6	1.5	1.4	1.5	1.7	1.3	1.3	1.3	1.4	1.7	1.6	1.5	1.5	1.5	1.7	1.7	1.4	1.6	1.9	1.4	1.6	1.6	1.5	1.1	1.4
RAISIN FLAVOR	MEAN	6.1	6.4	6.7	6.7	6.7	6.3	5.4	6.3	5.6	6.3	6.1	5.9	6.1	6.8	6.1	4.8	5.5	3.7	3.5	4.7	3.6	5.9	6.6	5.7	4.3	5.3	4.1
	S.D.	3.1	3.0	3.0	0.4	0.8	1.1	1.8	1.3	1.8	0.7	1.6	1.7	1.5	1.2	1.8	1.3	1.6	1.8	1.8	1.9	1.2	1.1	0.6	1.7	1.6	1.4	1.7
TEXTURE, NUTS	MEAN	6.1	6.1	6.3	6.2	6.5	6.3	5.9	6.4	5.9	6.2	6.3	5.2	6.2	5.9	5.8	5.8	6.0	5.4	5.5	5.6	5.1	5.9	6.0	5.7	5.4	5.9	4.6
	S.D.	1.5	1.5	1.3	1.1	0.9	1.0	1.1	0.8	1.8	1.0	1.1	1.8	0.9	1.3	1.2	1.1	1.1	1.3	1.3	1.3	1.6	1.0	1.0	1.1	1.3	1.0	1.7
TEXTURE, RAISINS	MEAN	3.5	3.7	3.3	5.0	5.2	4.8	4.4	4.6	3.9	5.5	4.9	4.6	4.5	4.6	4.4	4.4	4.4	4.5	4.6	4.6	4.1	4.5	4.2	3.9	4.9	4.8	4.0
	S.D.	1.2	1.6	1.1	1.2	1.5	1.4	1.7	1.5	1.4	1.5	1.6	1.4	1.4	1.8	1.2	1.4	1.3	1.6	1.4	1.0	1.3	1.5	1.5	1.0	1.4	0.9	1.3
APPEARANCE	MEAN	5.9	6.3	6.2	6.6	6.8	6.5	5.0	6.6	5.4	6.1	6.5	5.4	5.6	6.7	4.9	4.2	6.6	3.2	3.8	6.0	3.1	5.1	6.9	4.8	4.9	6.3	3.0
	S.D.	1.8	1.4	1.4	0.9	0.9	1.1	1.5	0.6	1.1	1.1	0.8	1.8	1.2	0.7	1.7	1.6	1.0	1.5	1.2	1.0	1.5	0.9	0.3	0.9	1.1	0.9	1.2

This document reports research undertaken at the U.S. Army Soldier Systems Command, Natick Research, Development and Engineering Center and has been assigned No. NATICK/TR-96/044 in the series of reports approved for publication.

THIS PAGE INTENTIONALLY BLANK

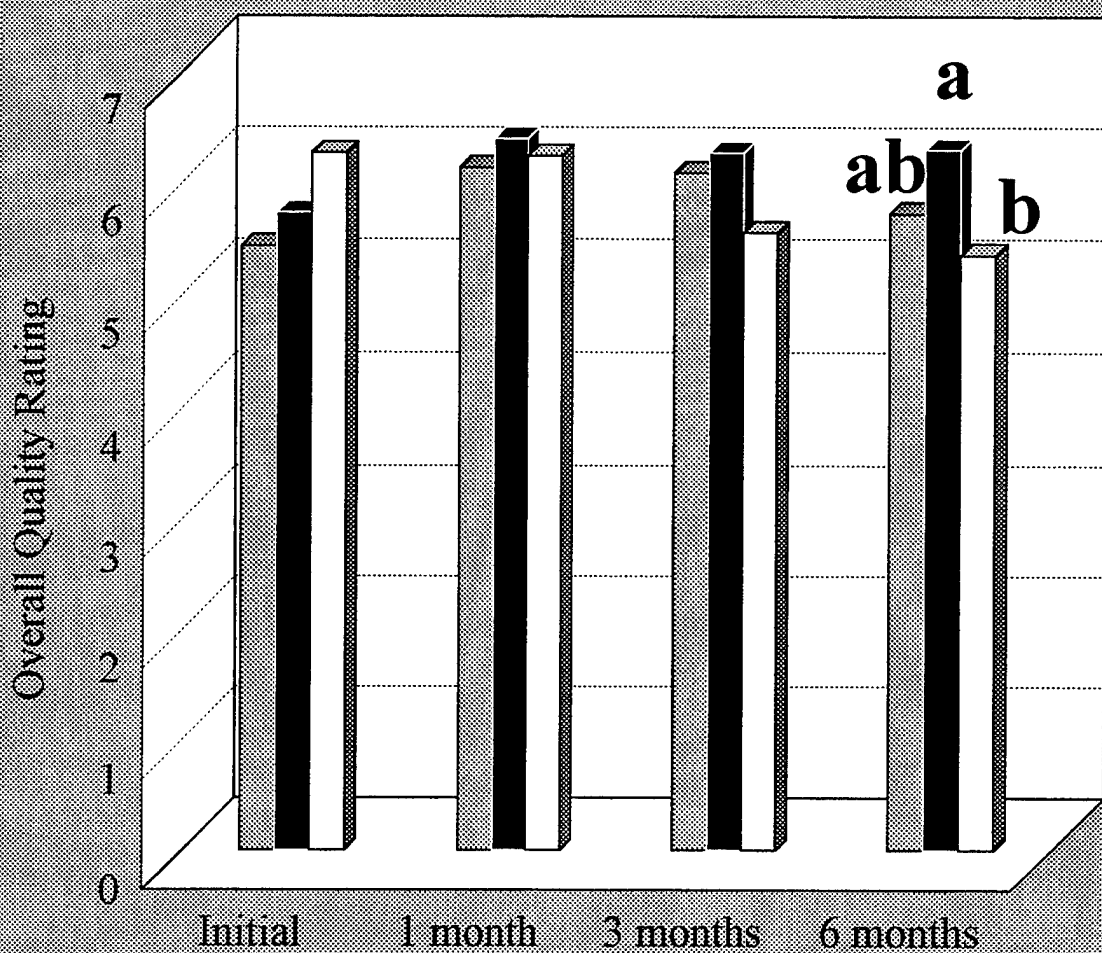
## REFERENCES

- Anonymous. 1987. Nut Raisin Mix (Operational Ration Component), Military Specification, MIL-N-44280(GL) 10 Aug.
- Bolin, H.R. 1980. Relation of moisture to water activity in prunes and raisins. *J. Food Sci.* 42:1190.
- Bolin, H.R. 1976. Texture and crystallization control in raisins. *J. Food Sci.* 41(4):1316-1317.
- Canellas, J., Rossello, C., Simal, S., Soler, L. and Mulet, A. 1993. Storage conditions affect quality of raisins. *J. Food Sci.* 58(4):805-809.
- Duxbury, D.D. 1986. Raisins inhibit molds, humectancy extends freshness. *Food Proc.* 47(4):110.
- Estevez, A.M., Escobar, B., Vasquez, M., Castillo, E., Araya, E. and Zacarias, T. 1995. Cereal and nut bars, nutritional quality and storage stability. *Plant Foods for Human Nutrition.* 47(4), 309-317.
- Frompovich, CJ Pubs. 1980. Fruits and nuts make nutritious snacks. Poster. Frompovich Publications, Coopersburg PA.
- Lagrange, V., and Payne, T.J. 1988. Shelf life extension of food products containing raisins and raisin products. *Cereal Foods World* 33:(2)211-214.
- Silge, M.R., and Callon, S. 1983. Fruit and nut ingredients for snack foods. *Cereal Foods World* 28(5):286-289.
- Stafford, A.E. and Guadagni, D.G. 1977. Storage stability of raisins dried by different procedures. *J. Food Sci.* 42(2):547-548.
- Ziemke, W.H. 1980. Raisins and raisin products. Mold retarding properties and raisin conditioning. *Am. Inst. of Baking Tech. Bull. II:(2):* 1-6.

THIS PAGE INTENTIONALLY BLANK

## APPENDIX

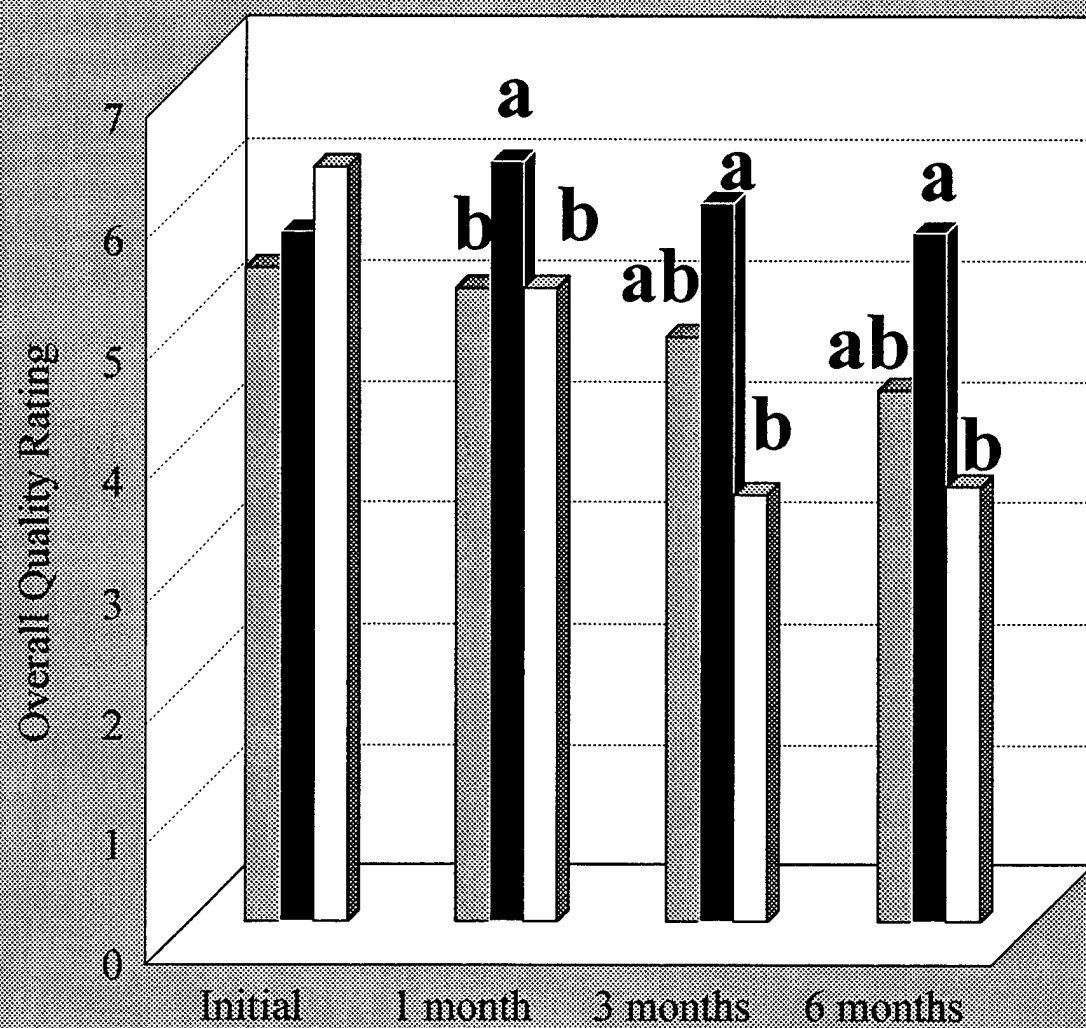
Figures 1-6



□ Vacuum    ■ No Vacuum    □ Vacuum & Increased Raisins

1 = extremely poor, 9 = excellent

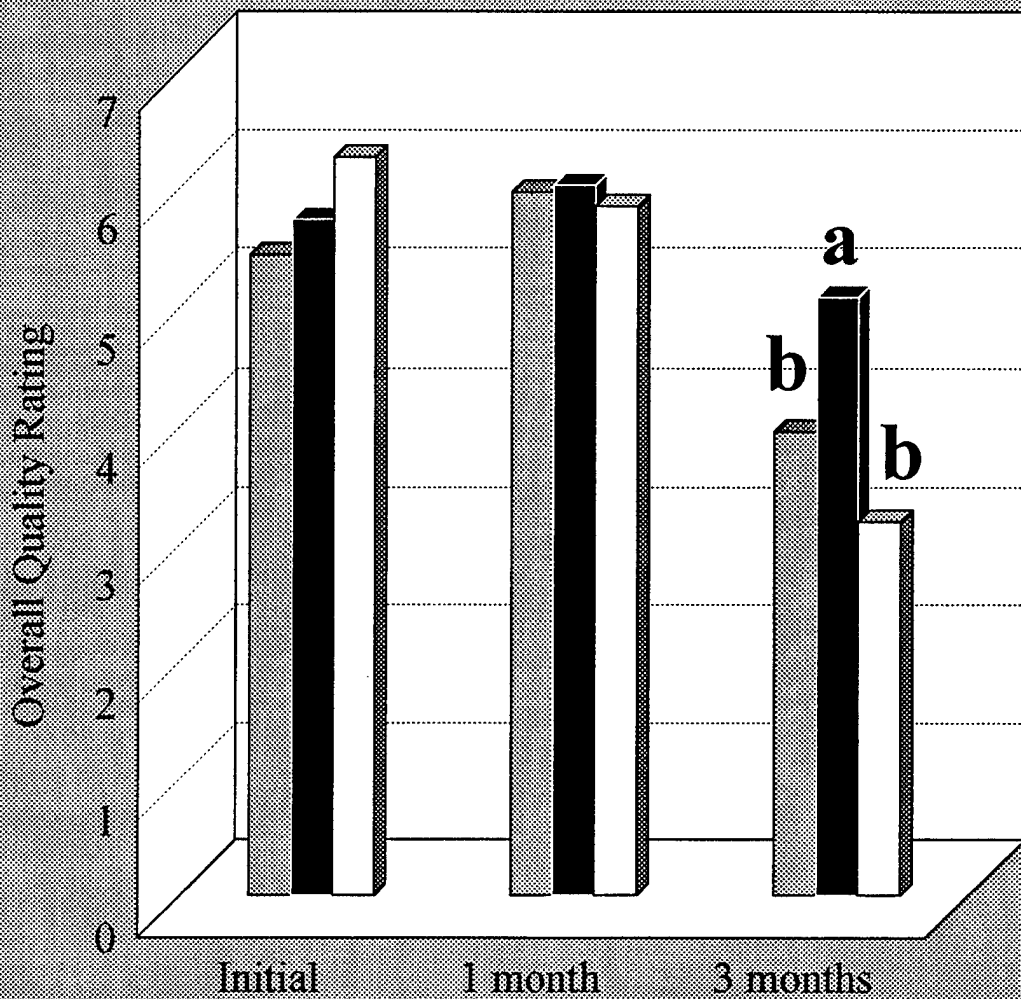
**Figure 1. Overall Quality Ratings after Storage at 27C**



☐ Vacuum   
 ☒ No Vacuum   
 ☐ Vacuum & Increased Raisins

1 = extremely poor, 9 = excellent

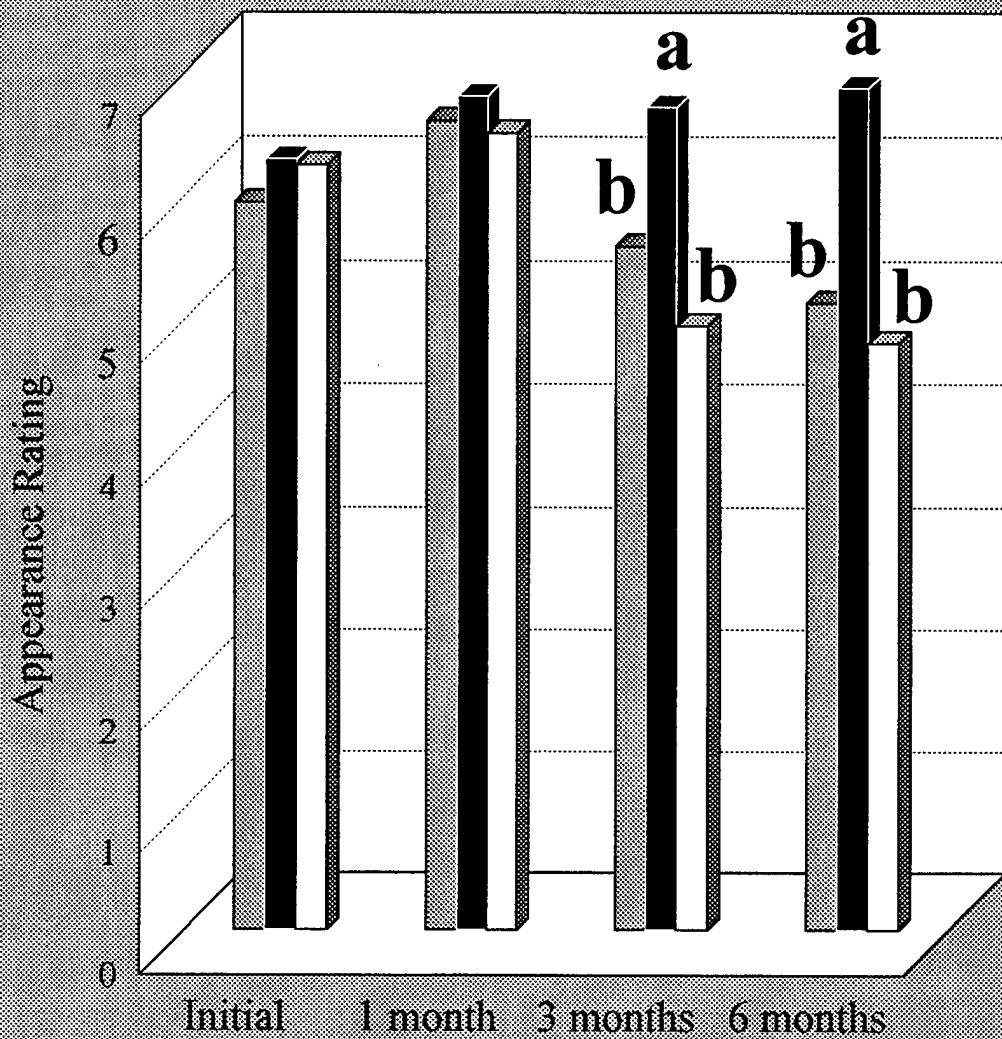
**Figure 2. Overall Quality Ratings after Storage at 38C**



□ Vacuum ■ No Vacuum □ Vacuum & Increased Raisins

1 = extremely poor, 9 = excellent

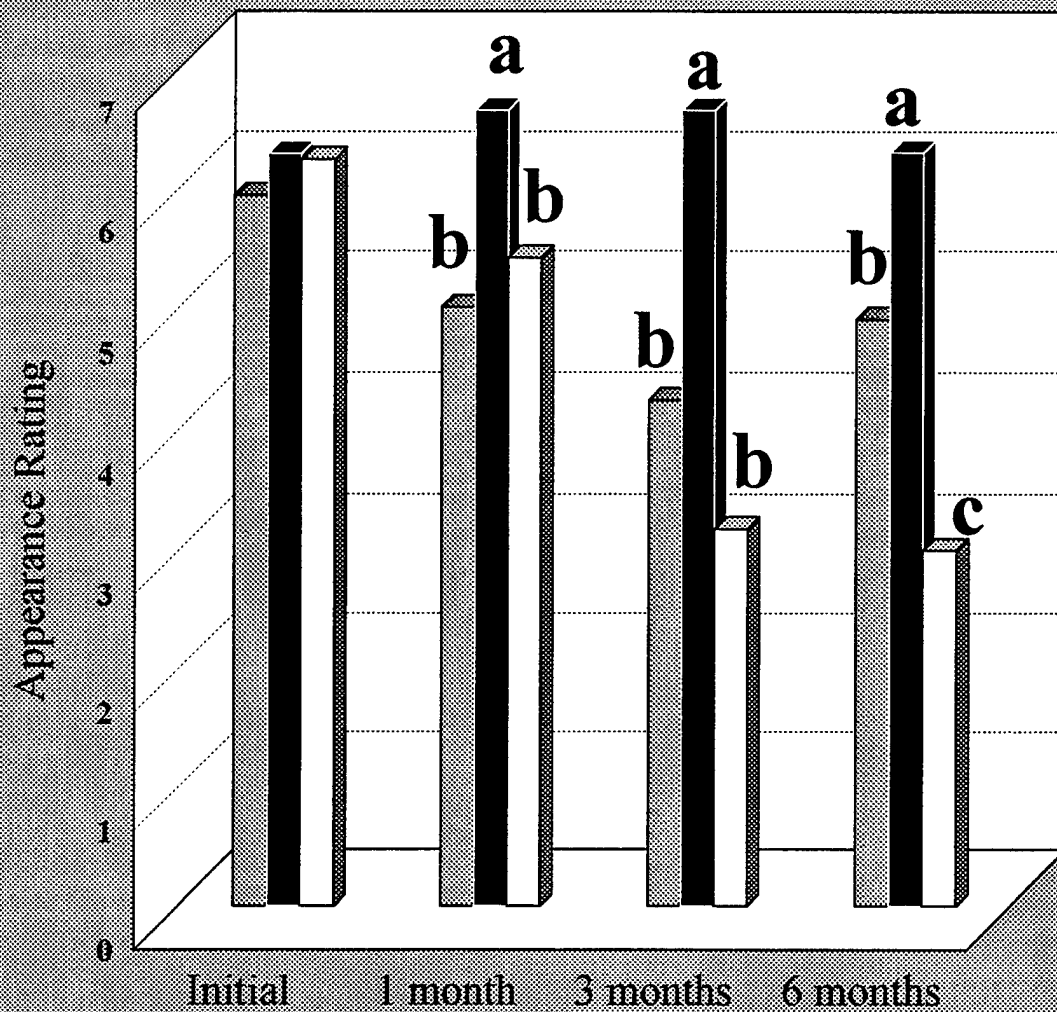
**Figure 3. Overall Quality Ratings after Storage at 49C**



□ Vacuum ■ No Vacuum □ Vacuum & Increased Raisins

1 = extremely poor, 9 = excellent

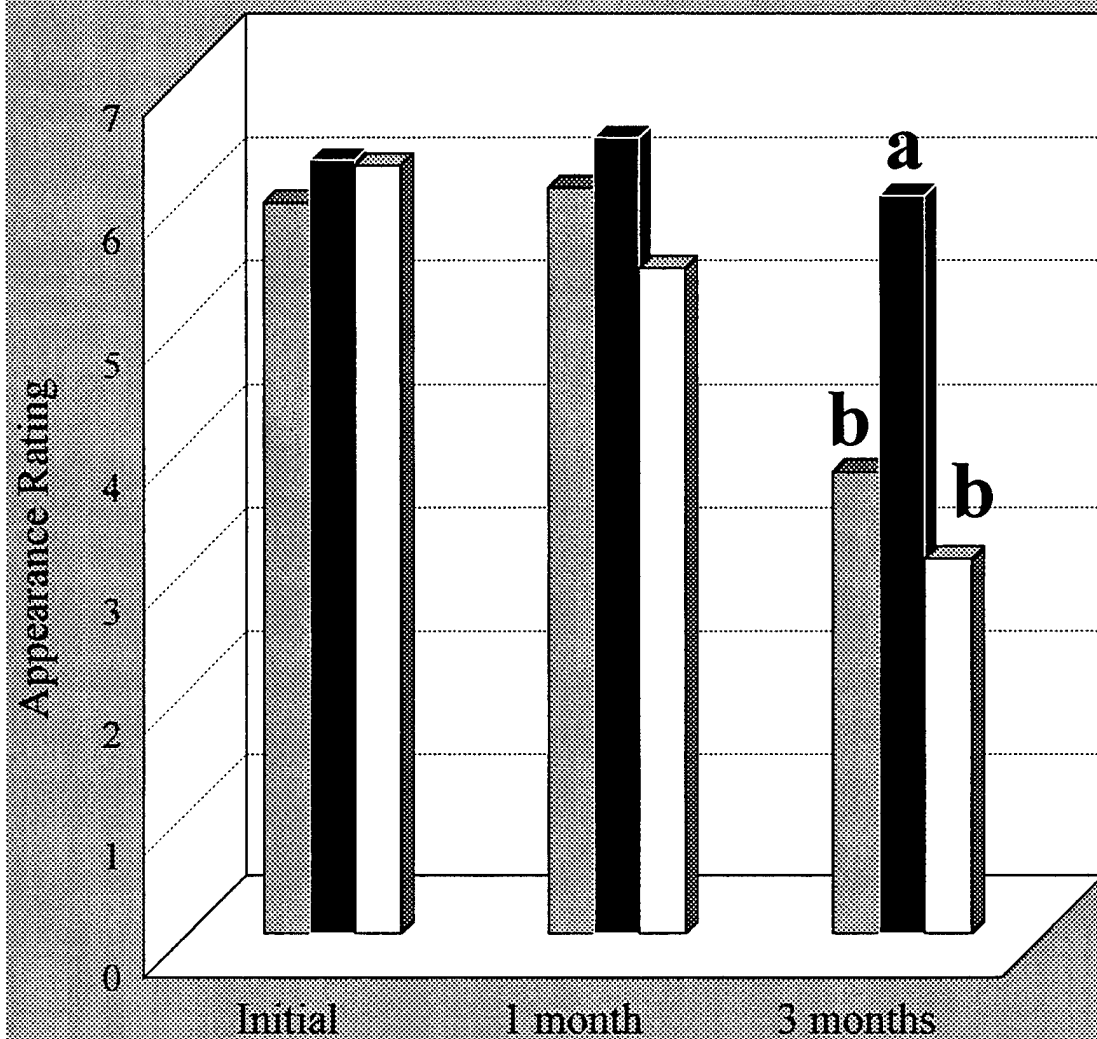
**Figure 4. Appearance Ratings after Storage at 27C**



☐ Vacuum   
 ☒ No Vacuum   
 ☐ Vacuum & Increased Raisins

1 = extremely poor, 9 = excellent

**Figure 5. Appearance Ratings after Storage at 38C**



□ Vacuum ■ No Vacuum □ Vacuum & Increased Raisins

1 = extremely poor, 9 = excellent

**Figure 6. Appearance Ratings after Storage at 49C**